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PRELIMINARIES TO MATHEMATICAL MOLDING OF THE FULL GRINDING PROCESS OF THE THREADS

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Abstract : The paper's goal is to elaborate a mathematical pattern for the full grinding process of the threads. Notions from the theory of the systems and the optimizing of the industrial process.

key words : molding, simulation, full grinding of the threads, optimizing..

1. Introduction

Generally, the full grinding process of the threads takes place in a single operation with two or three passages, according to the pitch of the thread. The full grinding process is accompanied by the release of a huge quantity of heat in the splitering zone.

The choice of the parameters of the grinding speed must be done in such a way as to avoid the combustion of the surface of the thread that is to ensure the cooling and the efficient lubrication of the half-manufactured product and of the abrasive wheel.

The intensity of thermal phenomenon and the action upon the pieces depends on the splitering speed and on the quality of the abrasive wheel, as well.

The full grinding of the thread on the hardened or non-hardened pieces can be done with one of the procedures presented in diagrams 1 a, b, c [1, 5]

The grinding using abrasive wheel with single coil, as shown in diagram 1 a, is available for large pitch threads, as well, up to 12- 15 mm or for very precise small pitch threads. In this case, the main motions are: The half-manufactured product makes the rotation turn and the equal advance with the pitch of the thread and the abrasive wheels makes the rotation movement.

In the case of the grinding using an abrasive wheel with several splitering coils as shown in the diagram 1 b, the width of the abrasive wheel being with 2-3 coils longer than the length of the surface to be rectified. In this case the wheel performs a rotation turn and the transversal advance turn to the barrier and a piece performs a longitudinal advance turn in addition to the rotation turn on a distance equal to 2-3 pitches of the thread.

The third option of grinding by using an abrasive wheel with splitering coils, as shown in diagram 1 c , the width of the wheel being smaller with ½- 1/3 from the length of the thread surface.

In this case, the wheel performs a rotation turn around its axle and an advance turn along the threaded piece, and the half-manufactured product - a rotation turn.

The concept of full grinding process of the threads appeared for the first time in the USA in 1939, due to the Thomson brothers who applied it on their thread grinding

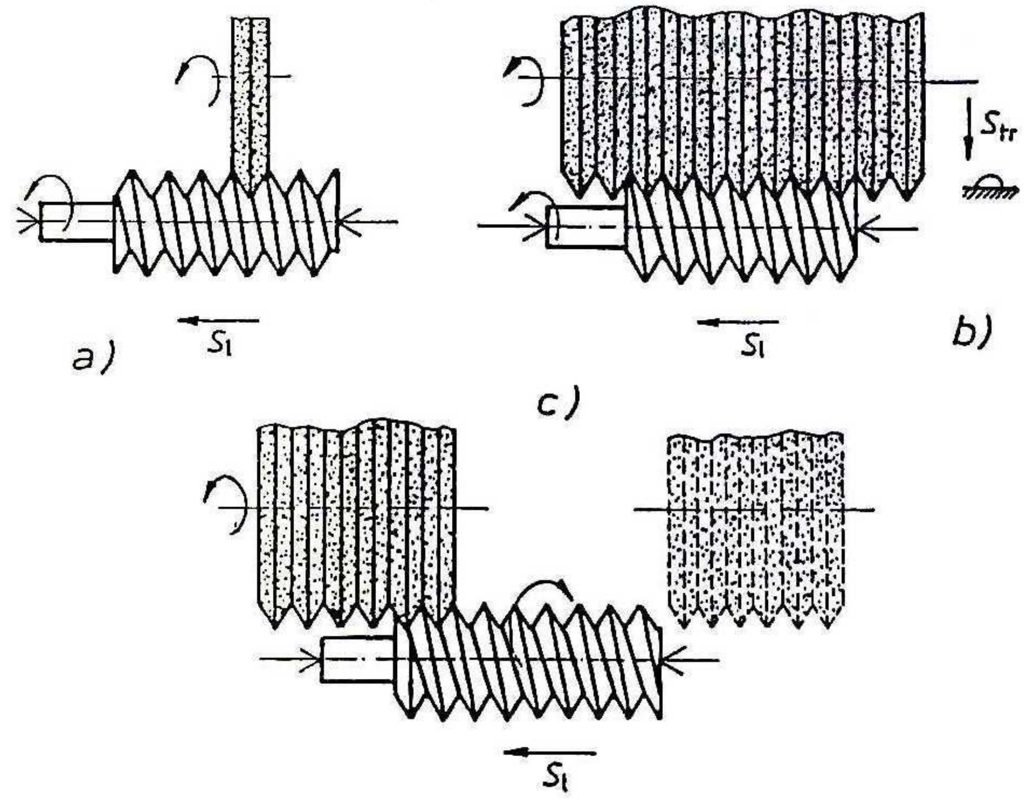


Fig. 1 (a, b, c) The full grinding procedures

machines. At the end of World War 2 this kind of machines were sent to Germany for The Marshall Plan.

The first European full grinding of the threads machines were put on the market by the Elk firm in German F R in 1959. From then on, other manufacturers joined; e.g. Mageli (Switzerland), Blohm (GFR), Jung (GFR), Camut (Italy). These machines are very easily adaptable to serial production, the full grinding of the threads appears in the car building.

2. Mathematical pattern for the full grinding of the threads process

The optimisation of the full grinding of the threads process requires the finding of the proper values, as shown in fig. 2. The splintering capacity of an abrasive wheel it`s determined by its type of material, by the structure and granulation of the wheel, by its temper and by the binding matter used.

The grinding process using an abrasive wheel with single coil having the given parameters invariable can be largely influenced by the chosen splintering process, this meaning: the domain of splintering speeds used, the longitudinal advances of the abrasive wheel and of the piece, the cutting depth that can determine the production of the thread in a certain number of transfers, etc [5].

Not only the parameters of the grinding process determine an optimal for the given wheel, but also other factors that derive from them. To be noticed here is the temperature resulted during the grinding, the endurance of the abrasive wheel, its wear, the heat- eliminating medium used, the vibrations and balancing of the wheel, etc.

In this paper the cumulate effect of the tool's parameters and of the splitering process` parameters upon the process in its whole was taken into consideration.

Often optimising of the endurance of the splintering tool are made on the assumption of a maximum productivity or of a minimum cost, incomplete methods following just some of the aspects of the splintering process, that's why the optimising process block was chosen, as shown in fig. 2

3. The acquirement of the mathematical pattern using experimental results

Any technological process can be described mathematically by a function that contains a lot of members, each one of them depending on at least one of its decision variables [1, 4, 5]

The equations that describe the technological process can be given or determined on the basis of some acquired experimental results. For the optimising on the computer of the splintering process at grinding, the acquirement of a mathematical pattern that describes as truthfully as possible the studied phenomenon is necessary .All the measurable phenomena that characterise the grinding process can be processed mathematically and transposed as relations. The form of the experimentally acquired curves can be similar to a curve with a known equation. The finding of the equations coefficients can be done easily by using the method of the smallest squares.

Our problem is the following: knowing the variations of two values determine the mathematical relation that can calculate one value depending on the other. It is possible for the two parameters to be in a correlation dependence, but not in a functional dependence.

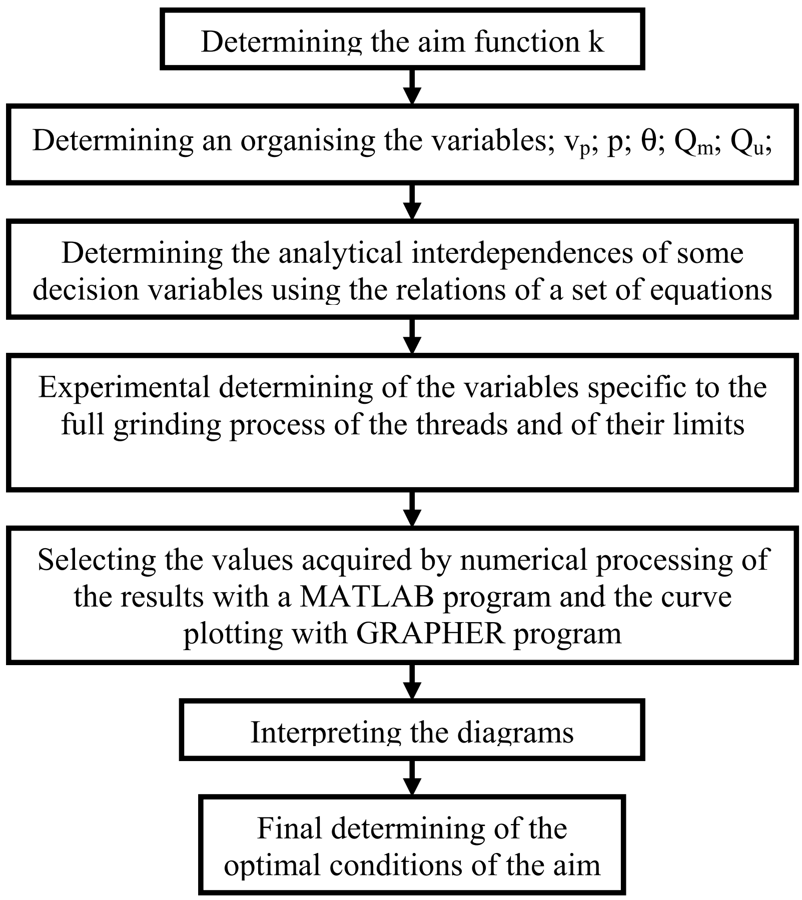


Fig. 2 – The block of the optimising process

4. Mathematical principles of the optimising in the grinding of the threads

$$y = f(x_1, x_2, \ldots, x_m). \quad (1)$$

As shown, the full grinding of the threads process can be seen as a function with more variables:

Once the equation that describes the mathematical process of grinding is obtained, an optimising criterion is used; this can be a productivity one, cont., power consumption, etc., requiring the evaluation of some values, expressions or relations that depend on the variables that define the proper process.

But, the optimising process has a series of limitations or restrictions, that, at the grinding of the metals, may be: The roughness of the tooled surface, the precision, the power consumption, the acquired solutions being applicable only if they respect all the restrictions imposed. The x_i variables in the function (fig. 2) are called decision variables; they determine the set through their values.

If the mathematical pattern of the set also has relations that define some variables depending on others, the number of the decision variables decreases along with the number of dependence relations.

If the mathematical relations that represent real, physical connection between the variables are more than the number of the decision variables, the optimising cannot take place.

If the function also has members that don't depend on the decision variables, these members do not affect the values of the decision variables that make the function maximal or minimal, but they modify the value of the function in the turning point. In the optimising process these members may be neglected.

If $f''(x)_{x=a} > 0$, point "a" is a local minimum, and if $f''(x)_{x=a} < 0$, "a" is a local maximum.

If $f'(x)_{x=a} = 0$, $f''(x)_{x=a} = 0$, $f'''(x)_{x=a}$ ¹ 0, point "a" is not a local optimum, but a \n inflexion point (the order of the first non- zero derivative being odd). If the order of the first non- zero derivative is even, point “a” is a turning point, that is a maximum if the

$$\frac{\partial f}{\partial x_1}\Big|_{x=a} = 0, \quad \frac{\partial f}{\partial x_2}\Big|_{x=a} = 0, \ldots, \quad \frac{\partial f}{\partial x_n}\Big|_{x=a} = 0. \quad (2)$$

derivative is negative or a minimum if the derivative is positive.

For a function with n variables $y = f(x_1, x_2, ..., x_n)$ the necessary condition for the function to have an extreme is that all the first order partial derivatives to be zero in point “a”:

$$\Delta^2 f = (x_1 - a_1)\left(\frac{\partial^2 f}{\partial x_1^2}\right)_{x=a} + \ldots + (x_n - a_n)\left(\frac{\partial^2 f}{\partial x_n^2}\right)_{x=a}. \quad (3)$$

For this condition to be sufficient as well , there must be evaluated the sum of the second order members from the evolution of the serial function Taylor.

If $\delta^2 f < 0$, point "a"is a local maximum, and if $\delta^2 f > 0$, point "a" is a local minimum. If $\delta^2 f = 0$, derivatives of a superior order must be evaluated.

When making up the program on the computer it's easier to look for all the turning points and to evaluate the function in each, finding the fitting point by simple comparisons. Among the solving patterns there is the substitution method and the Jacobean method. The former consists in explaining some decision variables from the restriction relations and their replacement within the function that will have now less decision variables, but will be more complicated. The latter method consists in solving the set of equations formed by restrictions and the Jacobean evolution.

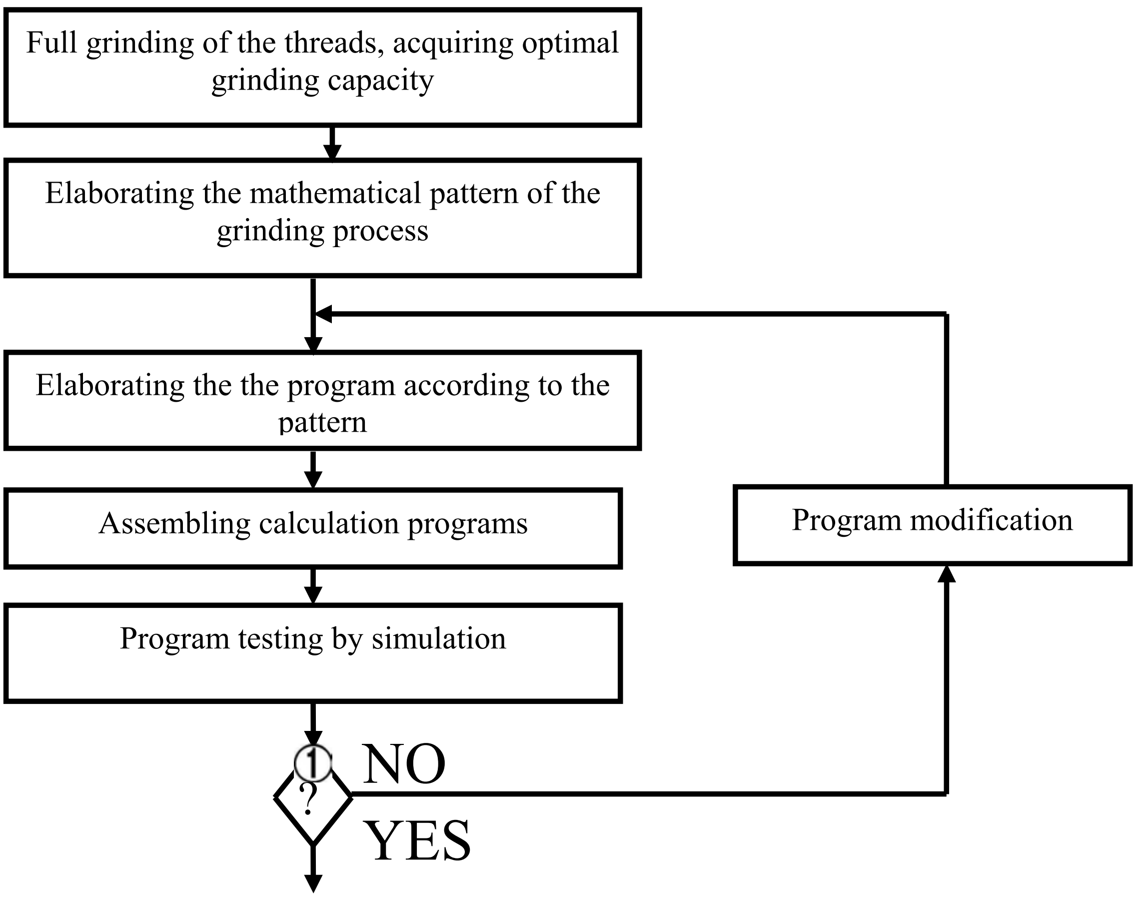
For $y = f(x_1, x_2)$ şi $u(x_1, x_2) = 0$ the set must be solved:

These methods offer the mathematical framework for solving some optimising problems, but they are only applicable to simple problems or to the partial solving of more complicated ones.

$$y = \begin{vmatrix} \frac{\partial y}{\partial x_1} & \frac{\partial y}{\partial x_2} \\ \frac{\partial u}{\partial x_1} & \frac{\partial u}{\partial x_2} \end{vmatrix} = 0, \qquad u(x_1, x_2) = 0. \tag{4}$$

Among the methods of acquiring the maximum and minimum of a function with some imposed restrictions there is the linear programming and non linear methods that use different determination algorithms.

From what has been shown it is noticeable that the aim function in the full grinding process depends on a large range of factors, that can be controlled properly only through an adapted command. The next paragraph presents the diagram and the principles of automatic control, with a computer of the studied process (fig. 3)



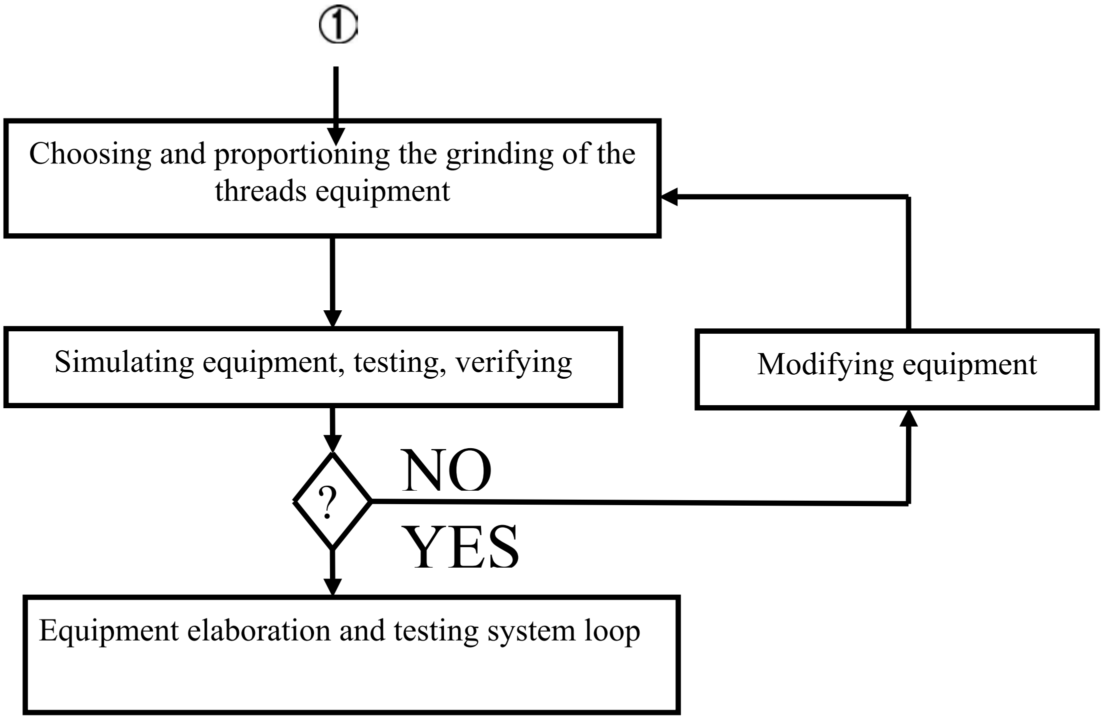


Fig. 3 – Logical diagram of projecting the automatic control of the full grinding of the threads process

5. Conclusions.

- The full grinding of the threads is suited to obtaining a mathematical pattern that can be the basis in the splintering optimizing process;
- With a MATLAB program simulations of different splintering processes were acquired compared to the experimental result.

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